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PRACTICAL SUGGESTIONS FOR THE PREPARATION OF FROZEN AND DRIED EGGS.

A STATEMENT BASED ON THE INVESTIGATION MADE IN THE PRODUCING SECTION DURING THE SUMMER OF 1911.

BY

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LETTER OF TRANSMITTAL.

United States Department of Agriculture,
Bureau of Chemistry,
Washington, D. C., March 15, 1912.

Sir: I desire to submit for approval and for publication the report of Dr. Mary E. Pennington concerning the investigations conducted under her direction during the season of 1911 on the handling, packing, and preserving of eggs. Dr. Pennington will submit at a later date a detailed report of this work. It is regarded, however, as of great importance to the industry, as well as to the consuming public, to have this preliminary report printed and circulated. It contains many suggestions which will undoubtedly be of great value to the industry and helpful to the consumer.

Respectfully,
H. W. Wiley,
Chief.

Hon. James Wilson,
Secretary of Agriculture.

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PRACTICAL SUGGESTIONS FOR THE PRERARATION OF FPOZEN AND DRIED EGGS.

(A statement based on the investigation made in the producing section during the summer of 1911.)

PURPOSE AND SCOPE OF THE INVESTIGATION.

In the summer of 1911 the Bureau of Chemistry, through its Food Research Laboratory, began an investigation of the frozen and dried egg industry. Simultaneously the Bureau of Animal Industry began a collaborative investigation of the same industry. The instructions of the Secretary of Agriculture to both bureaus were identical, namely, to find out, if possible, why some of these egg products on the market are undesirable foods, and to devise methods for the betterment of industrial practices, that the consumer may be protected and that eggs, which are wholesome in the producing territory, but which for one reason or another are not suitable for shipment to a consuming territory, may be conserved as near the source of production as possible.

The Department of Agriculture recognizes that it is responsible for the wholesomeness and, to a certain extent, the adequacy of the food supplies going to the people and is, therefore, concerned with food production and food conservation.

Enormous numbers of eggs spoil between the producer and consumer. A large part of this waste is incurred because the shipper sends many eggs to the market that are not adapted to weather the railroad haul and marketing. They are edible when they leave him; he hopes they will be edible when they arrive and that he may at least get back what they cost him. Frequently the spoilage is so great he scarcely receives freight charges. Such results are demoralizing to the shipper, to the commission man, and to the economic principles for which this country must stand if it is to continue to have sufficient food for its increasing population. The problem before us, therefore, is to save the eggs that would spoil before they can reach the consumer and to save them in such wise that they are a wholesome food.

The Omaha Food Inspection Laboratory was made the headquarters for the laboratory work involved and its entire force, as well as an additional force from the Food Research Laboratory, united to carry out the instructions given, and pushed the work until the end of the egg-breaking season of 1911. The Bureau of Animal Industry had its laboratory headquarters in Omaha also, but while the members of the two bureaus met for frequent conferences, the actual work was done quite independently. The factory part of the work was done in cooperation with the industry, six breaking plants in the West serving as the immediate field of operations.

The policy adopted in the prosecution of the work is the same as has been used in the cooperative investigation of the handling of poultry and eggs in the shell, namely, to work out in the laboratory the fundamental facts underlying the problem of the preservation of quality and the prevention of decay; to apply the indications for betterment obtained from the scientific work on a commercial scale just as promptly as possible and to gauge results not only by the customary methods of observation, but by laboratory examinations as well. The latter have been found to be far more delicate and more accurate than the former, and in addition they have the inestimable advantage of offering an impersonal and uniform method of comparison, which can be applied wherever trained men and laboratory facilities are available.

The study of the handling of perishable products to prevent waste is a new science and is eminently worthy of every effort that can be made for its extension, and its application to existing conditions that result in such enormous losses. Time, effort, and money are required to study each individual problem. The complicated systems of transportation and distribution prevailing in our country necessitate a wide field of investigation, when a perishable foodstuff is to be studied, and because many foodstuffs must be kept from the season of plenty until the season of scarcity, a long period of time may be required also.

It is not to be expected, therefore, that so complicated and so extended a problem as that of the preparation of dried and frozen eggs for food can be completed in one season. Neither is it possible to compile and prepare for detailed publication the mass of experimental work already done, in time for the industry at large to obtain the benefit of it during the coming summer. Such a report will be issued as soon as possible. It is believed, however, that a general statement concerning the lines of work that are being pushed and a brief summary of the results already obtained will be of interest to the egg industry, bakers, and those who are interested in food supplies, and perhaps be a help even at this stage of the work. The investigation is in no sense completed. It will be continued throughout the coming egg-breaking season. The principles already established will be extended and applied to the industry, and the study will follow the product from its source in the West to its final utilization in the East, that all phases of the problem may receive adequate attention.

A STUDY OF EGGS IN THE SHELL.

The instructions given to the investigators of this problem were "to begin at the beginning." The beginning of the conserved eggs of commerce is the individual egg. Hence the study began at this point to determine the differences, chemically and bacteriologically, between the various grades of market shell eggs in the producing districts and to correlate the information obtained in the laboratory with that of the practical candler that we may in the future have a more exact method of expressing grades than we now possess. To complete the information available to the egg breaker the appearance, odor, and sometimes the taste of the egg when removed from the shell are added to the candler's description and the results of the laboratory examination. The latter has consisted chiefly of the number of bacteria present, whether the organisms of the colon group were or were not present, and the amount of nitrogen obtained from the egg when it was analyzed according to the Folin aeration method. In eggs less than one day old, well handled, this nitrogen averages 0.0012 per cent when calculated on the fresh basis. As the egg ages the quantity of nitrogen evolved increases, until by the time the egg is almost a "white rot" it contains 0.0030 per cent or more. Market "seconds" in the producing section in summer time contain on an average from 0.0017 to 0.0022 per cent of nitrogen.

The fresh, sound, shell egg is for practical purposes free from bacteria, though it is not always sterile. It is free from organisms of the colon group so far as we know. "Stuck spots," "mold spots," definite blood rings, "white rots," eggs with a pronounced odor, "grass eggs" (those having a greenish color in the egg white), "musty eggs," and "sour eggs," that is, eggs having a pungent quality which is difficult to describe but which is recognized by the trained sense of smell, are ordinarily possessed of a high bacterial content. "Grass eggs," "musty eggs," "sour eggs," and eggs having a pronounced odor can not always be excluded by the candler. The others can and should be. The great majority of "seconds," "heated eggs," dirty shell eggs, and cracked eggs (not those from which the contents are escaping) show but few bacteria present when studied in the producing section. When cracked-shell eggs are kept, even for a few days, they frequently become infected with molds and bacteria.

When dirty shell eggs are stained, which generally indicates that wet filth has touched them, they may contain many organisms. When they do, they can usually be excluded because of a bad odor. Cracked eggs, or "checks" as they are called in the trade, dirty shell eggs, and "seconds," which signifies a grade including undersized, soiled, ''checked,'' and stale eggs, are commonly used by egg breakers. No ''spot'' eggs of any sort are used by reputable breakers.

Eggs in which the pungency of sourness is just beginning, eggs in which the faintest green of the ''grass egg'' can just be detected, and eggs that show a tendency for white and yolk to mix together but which are not, strictly speaking, ''rots'' must be further investigated in order to fix the dividing lines between good and bad eggs more sharply and definitely. This study is now under way, and the investigation of all the kinds of individual eggs will be continued since we can not have too much information on the subject.

Examinations of eggs which had been commercially candled for breaking were made at different times during the summer of 1911 in six different factories scattered over a fairly large area of the producing section and perfectly uniform results were obtained. With the exception of the eggs having green-colored whites, musty eggs, sour eggs, and eggs with pronounced odor, already mentioned, and which the candler can not distinguish, the eggs going to the breakers after a competent, careful candling are, bacteriologically speaking, a clean, wholesome food.

BACTERIAL CONTAMINATION DURING HANDLING.

GENERAL CONSIDERATIONS.

The eggs were handled, however, under very different conditions in these different houses and the product varied greatly in bacterial content, though the loosely combined nitrogen was not widely divergent. Apparently the chemical composition of the egg as it existed in the shell was maintained in the preparation of the product, at least so far as the nitrogen evolution would indicate. The nitrogen obtained from the same eggs, opened carefully in the laboratory and analyzed at once, confirmed this observation. But that the bacterial content of the preparations is very largely a matter of handling is proved not only by the variation between the output of different plants, but from the fact that when the eggs used by all of them were opened in the laboratory under aseptic conditions, they were found to contain but few bacteria. Conversely, when an attempt was made in the laboratory to open the eggs according to the methods prevailing in the egg-breaking establishments the content of organisms was greatly increased and sometimes approximated very closely the product obtained in the commercial establishment.

The preparation of frozen and dried eggs parallels the milk problem. In dairying it is first necessary to obtain a cow giving good milk. Then her product must be so handled that it is maintained in good condition until it reaches the consumer, a question that has engaged the attention of sanitarians for many years and is still the subject of study. The hen seems to be more reliable as a producer of good eggs than is the cow of good milk. In either case the ignorance or carelessness of man results in the addition of multitudes of bacteria which can, and frequently do, spoil the product for food purposes. The fundamental in the handling of wholesome milk is *cleanliness*. The fundamental in the handling of good eggs is also cleanliness, a cleanliness based upon and adapted to the work to be accomplished. In the study of the handling of milk every building, every operator, every utensil, every vessel, has been specifically studied that sources and foci of bacterial infection might be located and eliminated. This investigation has adopted the same principle in regard to the handling of eggs, and, as in the study of dairying, the sources of contamination are best located by bacteriological methods. The entire breaking room in every plant studied was investigated in detail—air, water, small containers, large containers, etc.

CARE OF THE FINGERS.

The fingers of the breaker are one prolific source of trouble. They are constantly wet. They thus become contaminated by the dirt on the shells as well as wet with bad eggs that are thrown away. A long-continued wet condition roughens the skin, making the fingers ready lodging places for bacteria, and washing avails but little. If the fingers are kept dry most of the trouble they cause is removed. Plate I, figure 1, shows the bacterial growth which developed just where the 5 fingers of an egg breaker touched the surface of the jelly on which the bacteria, if there were any, would grow. Figure 2 gives a better idea of the number of bacteria which such a hand will carry; even the tiniest spot represents bacterial growth. Figures 3 and 4 show the difference between working with the dry and the wet fingers. One girl, "A," worked in the usual commercial fashion; "B" kept her fingers dry by means of clean tissue paper. The results speak for themselves. The usual wet, dirty rag, which almost universally pervades the egg-breaking rooms, and is used for cups, fingers, and the floor, indiscriminately, is so obviously objectionable, in the light of the foregoing demonstrations, that it needs no further mention.

CARE OF UTENSILS.

An egg usually contains either comparatively few organisms (not more than 10,000 per gram) or it contains millions of bacteria per gram. In other words, an egg, bacterially speaking, is generally either very good or very bad. When a bad egg comes to the breaker, and it is not possible with our present knowledge to guard against this happening, it gets on her fingers and into the saucer, tumbler, cup, pan or whatever receptacle she may be using. She throws it into the bucket intended for the tanner's grade or into the waste can, rinses her receptacle either in running water or, more frequently, in a bucket of water which stands beside her. She also rinses her fingers. But the water does not remove the bacteria. There are still millions adhering to the surface of the dish or cup, of which the breaker knows nothing. It looks and smells clean, but the next good egg entering it and the next and the next pick up and carry on the bacteria that the bad egg furnished, even though that egg was thrown away.

Plate II shows the part the utensils play in passing on bacteria. Figure 1 shows the result of just touching the top of a glass tumbler, which had been used during the morning to receive eggs, against a surface permitting the growth of bacteria. Each little spot, as well as the heavy cloud over most of the surface, indicates the presence of bacteria on the edge of the tumbler, though they were not to be perceived by any of the senses unaided. Figure 2 shows the great number of colonies, as indicated by the dark spots from the size of a pen point to that of a small pea, coming from one drop of water on a saucer that had been washed in running hot water after receiving a bad egg. It seemed to be clean but was not. Even the superficial steaming over a jet, which is frequently accepted as a guaranty of cleanliness, is not sufficient to kill the bacteria which get on the egg utensils. Figure 3 shows the result of steaming for one-half minute. It is an improvement over mere washing but is far less efficient than steaming in a closed vessel for 15 minutes, the result of which is shown in figure 4.

Vessels wet with water on their outer surfaces, drippings of egg, and accidentally spilled eggs cause the breakers to put trays or shallow pans under their breaking apparatus for the sake of cleanliness. These become sloppy with "drip." The contents go into the bucket of tanners' eggs, generally, but long before being dumped into that drops have fallen off the cups or glasses into the food buckets. Needless to say, the "drip" has an enormous number of bacteria in it. It can be almost excluded by properly constructed apparatus, and what little does collect can be rendered innocuous. Figures 3 and 4, Plate III, show how many bacteria enter the product from this source.

The cleaning of the utensils, large and small, is not possible unless facilities are at hand for long steaming in a closed vessel. Buckets, pails, mixers, strainers, etc., are used day after day. Each day's use roughens the surface more and more, and each roughness makes the lodgment of bacteria easier and cleansing more difficult. Only the long-continued application of live steam will kill the germs. The practice of washing all the utensils at the end of the day in a big

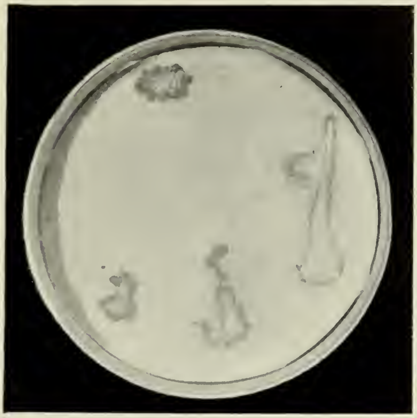

FIG. 1.—Impression of finger tips on poured agar plate.

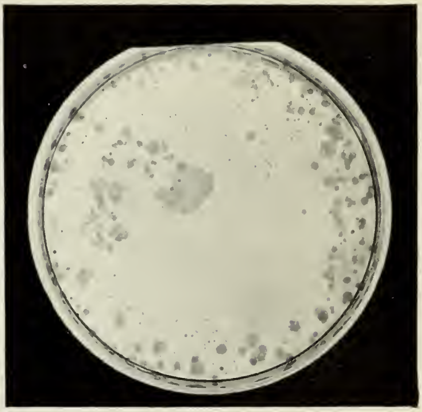

FIG. 2.—Dry plate touched with finger tips after rinsing, agar then poured on and shaken.

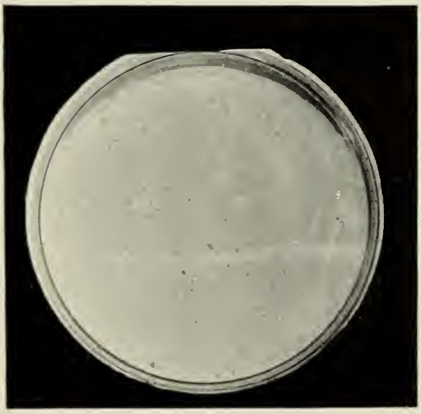

FIG. 3.—A's finger tips; commercial habits.

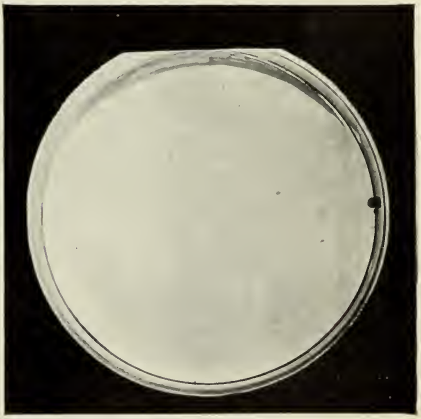

FIG. 4.—B's finger tips: kept dry with tissue paper.

PETRI PLATES SHOWING BACTERIA ON FINGER TIPS OF BREAKERS.

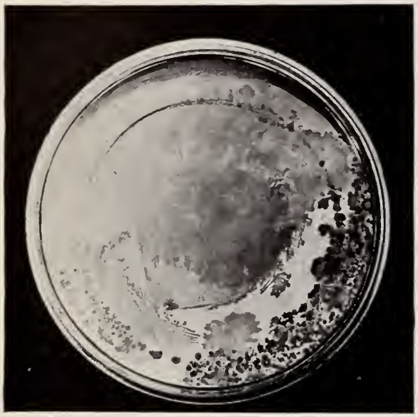

FIG. 1.—Bacterial growth induced by touching the agar plate with the top of a washed tumbler.

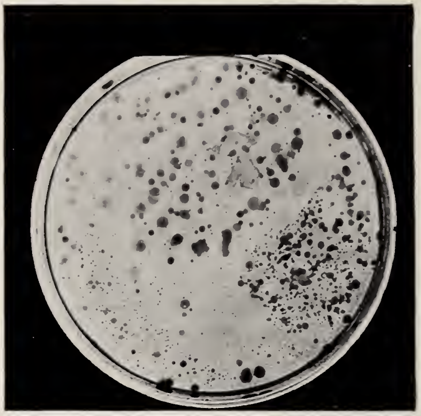

FIG. 2.—One drop of water from washed saucer in which bad egg had been broken.

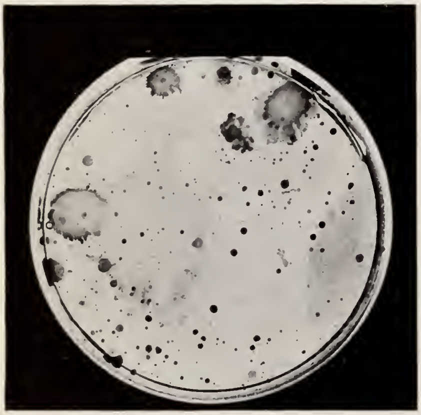

FIG. 3.—Two drops of water from sherbet cup washed and steamed one-half minute over a jet.

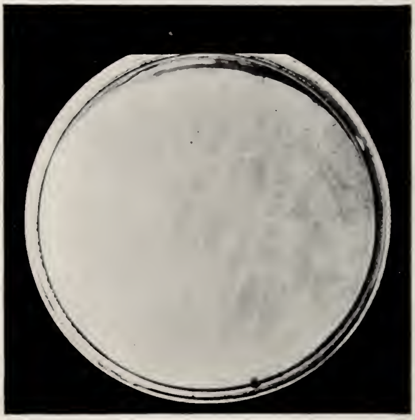

FIG. 4.—One-half teaspoonful of water from sherbet cup steamed in closed vessel 15 minutes.

PETRI PLATES SHOWING BACTERIA ON EGG CUPS AND SAUCERS.

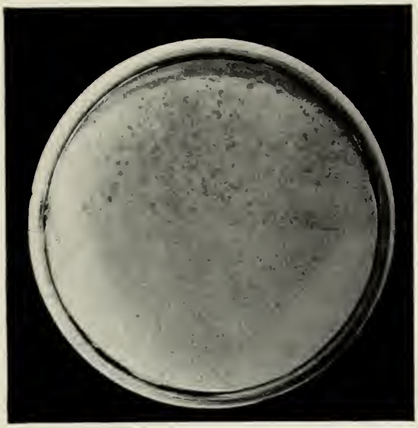

FIG. 1.—One drop of water from washed pail.

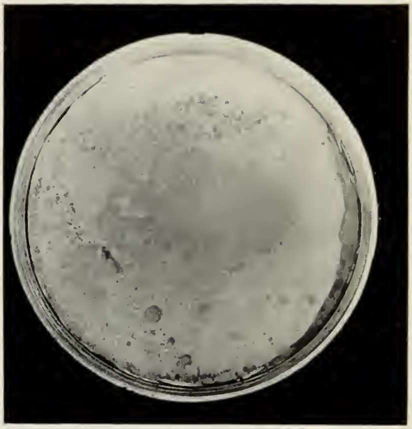

FIG. 2.—One drop of the water in which pails, etc., were washed.

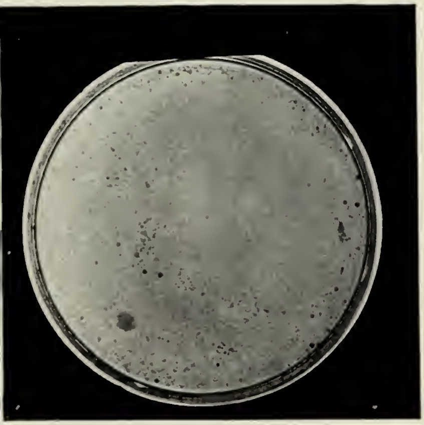

FIG. 3.—One drop of "drip" from shelf holding saucer.

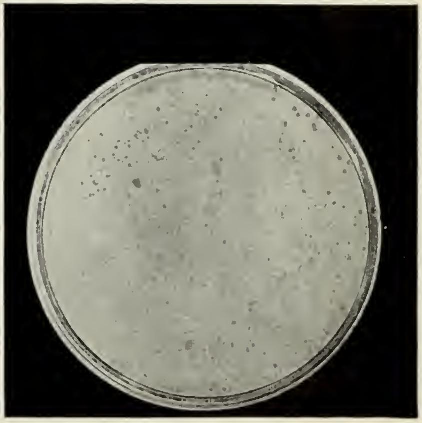

FIG. 4.—One drop of "drip" from tray in which pails sat.

PETRI PLATES SHOWING BACTERIA IN "DRIP" FROM UTENSILS.

sink, which is filled with water, is to be deprecated. Even careful rinsing after soaking in that tank, which is loaded with billions of organisms, will not cleanse. Figure 1, Plate III, shows the number of bacteria in one drop of water from a pail so washed and rinsed; figure 2 shows one drop of the water in which it was washed.

All of these sources of contamination were located by bacteriological methods, and the remedies were proved to be efficient in the same way. Apparatus was also devised that is adapted to cracking the shell cleanly and collecting the contents (see fig. 1).

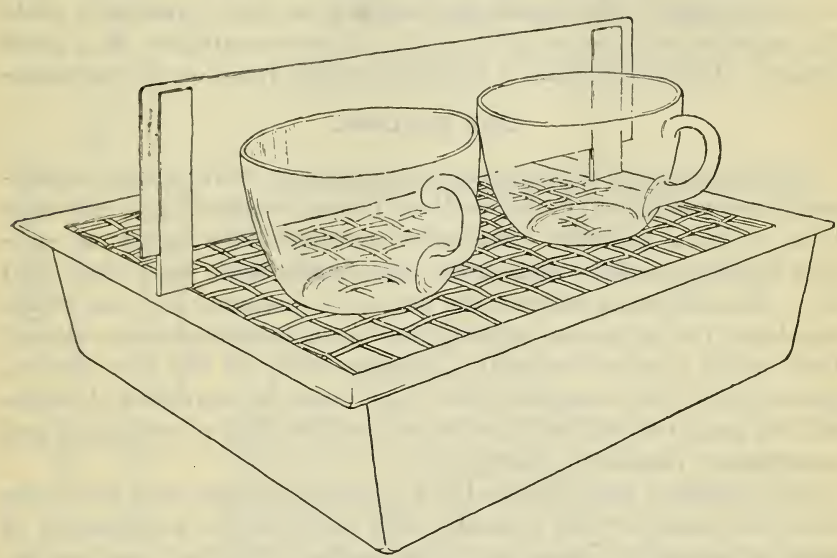

FIG. 1.—Egg-breaking outfit.

[A tin pan, 10 by 10 by 2 inches, having a tin-bound wire screen, ½-inch mesh, fitting firmly over the top. In the middle, at opposite sides, are uprights 3 inches high, each having a slot into which is slipped a piece of tinned boiler steel. The slot binds at the bottom to hold the steel strip firm. It is sharpened on its upper edge. This knife gives a clean crack in the egg shell and can readily be replaced after a bad egg. The sherbet cups are of smooth glass. They withstand steam sterilization. A larger container than a sherbet cup can not safely be used. Neither can an opaque vessel be used. Glass is necessary for good grading.]

EQUIPMENT.

The construction of a suitable room for egg breaking has also been studied. Such equipment embodies the following essentials:

A refrigerated breaking room wherein the temperature does not rise above 65° F. and which is preferably free from wood with nonabsorbent walls, ceiling, and floor. The light should be natural and plentiful. The room should be free from dust and have an abundant fresh air supply. All apparatus used in this room should be of metal or of a material permitting of absolute cleanliness, such as slate. Every utensil which the egg touches should be steam sterilized, and all apparatus should be sufficiently plentiful to insure a clean supply constantly at hand. The breaking outfit should be especially constructed that bacterial cleanliness may be preserved. Arrangements should be made for washing and sterilizing utensils outside of the breaking room. All eggs should be chilled at a temperature below 40° F. for 24 hours, as soon as received, candled in a chilled candling room (not above 65° F.), and transferred as soon as candled to the breakers. The liquid egg should go at once, preferably while the temperature is below 45° F., in its ultimate containers, to a quick freezer. This necessitates a low-temperature room on the premises·

THE OUTLOOK.

As the sources of the bacterial contamination were located, experiments were instituted in the breaking houses cooperating to eliminate them as far as possible. Makeshift sterilizers were rigged up, suitable breaking outfits were tried, and fingers were kept clean and dry. The difference between the product so prepared and that which was being put up was so striking that certain establishments altered their whole routine forthwith. Further study of the new routine, elaborations here, simplifications there, must be continued throughout the season of 1912 at least, as well as the study of unfinished and unexplained details of grading, etc.

It is believed that the study of dried and frozen eggs along the lines laid down in this summary will result in the acquirement of definite knowledge concerning these products and their preparation, which will enable the egg breaker to put out a product of such grade that it will be above reproach, and which will become more and more widely used for cooking purposes as its reputation and quality become more stable. It is believed that it is not possible to break eggs for freezing and drying amid the insanitary surroundings and with the apparatus now prevailing in many places. Special equipment and facilities are necessary. It would seem that the logical location for egg-breaking establishments is at the first concentrating center, not at the final consuming center. Both the quality and the quantity of the product are increased by preparing it as near the source of production as possible.

It is believed also that, properly conducted, the freezing and drying of eggs is an industry which is economically desirable, as long as the centers of egg production and egg consumption are so widely separated, and as long as the poor handling methods bring to the concentrators of the producing sections such enormous numbers of eggs that are wholesome but not available for long hauls.

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